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Short communication

A note on the effects of co-mingling piglet litters on pre-weaning growth, injuries and responses to behavioural tests

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Abstract

The purpose of this study was to determine how co-mingling litters affected piglets' pre-weaning growth, ear injuries, suckling behaviour and responses to behavioural tests used to measure coping abilities. Thirty sows and their respective litters were housed in standard farrowing crates until day 13 after birth. On day13, the partition between two neighbouring pens was removed for 20 litters allowing piglets to interact (forming 10 co-mingled litters). The remaining 10 control litters were kept in standard farrowing crates throughout the experiment. Three focal piglets from each litter were used for data collection. Focal piglets were weighed and ear injuries recorded on days 2, 4, 9, 12, 15 and 18 after birth. There were no differences in piglets' weight gain before or after co-mingling. Ear injuries were more abundant in co-mingled litters on day 15 ($P < 0.05$) but these differences disappeared by day 18. Suckling behaviour was recorded on days 5, 8, 10, 14, 16 and 18 after birth. There were no differences in teat fidelity, suckling frequency and mother fidelity between treatments. Three behavioural tests, social challenge, isolation, and backtest, were performed before and after co-mingling. There were no treatment effects on piglets' response to the isolation test and backtest. Co-mingled piglets showed longer latency for the first aggressive interaction ($P < 0.05$), spent more time in proximity to one another ($P < 0.05$) and performed less single bites ($P < 0.05$) than control piglets during the social challenge. In addition, the duration and frequency of aggressive interactions ($P < 0.05$) were lower in co-mingled piglets than control piglets. Co-mingling did not affect the frequency of single head thrusts or oral–nasal contact, but did tend to increase the frequency of escape attempts ($P < 0.10$). Our results suggest that co-mingling

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litters during lactation affects piglets' social behaviour, by primarily decreasing aggressive interactions during social challenges.
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1. Introduction

In social species, such as pigs, the presence of conspecifics can be a significant aspect of the early environment. In fact, co-mingling piglets from different litters prior to weaning alters piglet development enabling them to cope better with future challenges. Co-mingled litters have higher weight gain and food consumption after weaning than non co-mingled litters (Weary et al., 2002). When mixed with unfamiliar individuals, co-mingled piglets establish a dominance hierarchy more quickly (D'Eath, 2005), and spend less time involved in aggressive behaviours than control piglets (Weary et al., 1999a; Parratt et al., 2006).

Coping has been defined as the behavioural and physiological efforts to master a situation (Koolhaas et al., 1999). Two coping styles, ''active'' and ''passive'', are well defined for some species (see Koolhaas et al., 1999 for a review). Even though the existence of distinct coping styles in pigs is controversial (Jensen et al., 1995), studies on coping abilities have provided insights into piglet behaviour (Hessing et al., 1993; Ruis et al., 2001).

Behavioural tests have been used to identify possible behavioural patterns indicative of coping styles. Hessing et al. (1993) introduced the backtest as a general assessment of pigs' coping styles. According to Benus et al. (1991) passive copers are less social, less aggressive and show longer attack latencies than active copers. Consequently, social challenges, in which piglets are allowed to interact with unfamiliar individuals (D'Eath and Burn, 2002) and social isolation tests (Ruis et al., 2001) have been used as indicators of pigs coping styles.

In pigs, the effects of co-mingling litters on coping abilities before weaning are unclear. Thus, in the present study we investigated whether co-mingling litters affected piglets' growth, injuries and the results of behavioural tests designed to measure coping abilities before weaning.

2. Methods

Thirty multiparous sows (York × Landrace) and their litters from the Purdue University Swine herd were used. Individual sows and their litters were assigned to treatments and attempts were made to balance for farrowing date, sire ID, parity, litter size and litter sex ratio. The experiment was organized in five replicates of six sows (and their litters). On day 1 after birth, all sows and their litters were moved to specific farrowing pens prepared with video recording equipment. The pen's dimensions were 2.55 m × 0.55 m × 1.50 m, including a farrowing crate (2.24 m × 0.55 m × 1.00 m) for the sow and a creep area with a rubber mat (0.90 m × 0.30 m) under a heat lamp on either side of the farrowing crate. On day 2 after birth, all piglets were weighed and processed following standard commercial practices (teeth clipping, tail docking, ear notching, iron injection and males were castrated).On day 4 after birth, three focal piglets were selected for behavioural observations and marked on their backs. On day 13, the partitions between two adjacent farrolwing pens were removed for 20 litters (i.e. two pairs of pens per replicate) allowing two litters to co-mingle at a time. The remaining 10 litters (i.e. two litters per replicate) served as controls. Focal piglets were individually weighed and the presence or absence of ear injuries recorded on days 2, 4, 9, 12, 15 and 18 after birth. Suckling behaviour was recorded using direct observations on days 5, 8, 10, 14, 16 and 18 after birth

for 18 litters (6 control and 6 pairs of co-mingled litters). Teat fidelity [(observations at most used teat/total observations) × 100], suckling frequency [(nursing events piglet is present/total observations) × 100] and mother fidelity [(at mother's udder/total observations) × 100] were also calculated.

The backtest, isolation test and social challenge were performed on all focal piglets. The backtest was conducted twice before co-mingling (days 9 and 11) and twice after co-mingling (days 15 and 17), following the method described by Hessing et al. (1993). For the purpose of the analysis, behavioural data from the two backtests performed before co-mingling were combined and the two after co-mingling were combined, following Hessing et al. (1994).

The isolation test was performed once before co-mingling (day 9) and once after co-mingling (day 15). For this test, each focal piglet was individually placed in a 1.22 m × 0.91 m × 1.22 m test box for 10 min, using an adaptation of Weary et al. (1999b). The duration and frequency of active (piglet standing on four legs) and resting behaviours (piglet sitting on two legs, or lying with no apparent movement), and the number of escape attempts (piglet jumping against box walls) were recorded.

The social challenge was performed once before co-mingling (day 10) and once after co-mingling (day 16). For this test, a pair of focal piglets from different litters, but from the same treatment, were placed in a 1.22 m × 0.91 m × 1.22 m test box and allowed to interact for 10 min, similar to Jensen et al. (1995). Opponent piglets were the same both times the social challenge was performed. Data collection started as soon as the second piglet was placed inside the test box (within 3 min of the first piglet). Behavioural measurements were quantified from video recordings and were: the duration, frequency and latency for aggressive interaction (piglets side by side, pushing, head thrusting against and biting each other), time spent in proximity (piglets located within one body length from each other), time spent apart (piglets positioned at least one body length distant from each other for a minimum of 2 s), and the frequency of bites and head thrust (single bites or head trusts, not involved in a aggressive interaction) oral nasal contact (oral–nasal contact towards any part of the other piglet's body, including sniffing, separated by 2 s) and escape attempts (piglets jumping against box walls).

2.1. Statistical analysis

Treatment comparisons (control = CT, co-mingled = CM) were analyzed using each pair of co-mingled litters as an experimental unit along with each individual control litter ($n = 10$ for CT, $n = 10$ for CM). The average of all focal piglets within the experimental unit was used for data analysis (mean of three piglets for CT and mean of six piglets for CM).

Focal piglets' mean daily weight gains were calculated from the weight data collected. Data were analysed using a repeated measures analysis of variance using the PROC GLM procedure in SAS (SAS Inst. Inc., Cary, NC). The presence or absence of ear injuries was analysed using a split–plot design, through GLM in Minitab v.14. Tukey pairwise comparisons were performed in order to test for the days in which treatments differed. Suckling data were analysed using the two-sample Wilcoxon–Mann–Whitney test, using PROC NPAR1WAY in SAS (SAS Inst. Inc., Cary, NC). Behavioural tests treatment comparisons were made using GLM in Minitab v. 14. Tukey pairwise comparisons were performed for significant interactions. Resistance classification of piglets during the backtest was analysed through chisquare, using PROC FREQ in SAS (SAS Inst. Inc., Cary, NC).

3. Results

Focal piglets' mean daily weight gains did not differ between treatments for the whole experiment (227.54 ± 0.01 g/day versus 243.87 ± 0.01 g/day; CM versus CT, respectively) or at any time point. Co-mingled piglets had more injuries 2 days after co-mingling (CT = 0.43 ± 0.12, CM = 0.88 ± 0.04, $P < 0.05$), but these differences disappeared by day 18.

There was no difference in piglets' suckling behaviour (teat fidelity, suckling frequency or mother fidelity) throughout the experiment. Cross suckling was never observed during milk

Table 1
Effects of co-mingling on piglets' responses during the social challenge test (interaction with an unfamiliar piglet)

Comparisons between treatments	Control	Co-Mingled	*F*-value	*P*-value
Duration in proximity (s)	554.4 ± 13.6	581.29 ± 4.04	$9.74_{(1.39)}$	< 0.05
Duration of aggressive interaction (s)	52.5 ± 17.8	46.0 ± 16.2	$6.25_{(1.39)}$	< 0.05
Frequency of aggressive interaction	4.24 ± 1.30	2.50 ± 0.72	$10.42_{(1.39)}$	< 0.05
Latency to first aggressive interaction (s)	353.3 ± 57.1	424.9 ± 36.0	$5.29_{(1.39)}$	< 0.05
Frequency of bites (in-non aggressive interaction)	2.38 ± 0.45	1.47 ± 0.38	$6.58_{(1.39)}$	< 0.05
Frequency of head thrusts (in non-aggressive interaction)	3.19 ± 0.63	2.83 ± 0.47	$0.88_{(1.39)}$	NS
Frequency of oral-nasal contact	27.95 ± 3.05	28.40 ± 2.40	$0.03_{(1.39)}$	NS
Frequency of escape attempts	0.61 ± 0.38	2.8 ± 0.61	$3.30_{(1.39)}$	< 0.10

Co-mingling occurred on day 13. Data expressed as means ± S.E. (of raw data).

ejection. Only four teat disputes by the focal piglets (one from CT, three from CM litters) were observed.

During the backtest, control and co-mingled piglets did not differ in the duration of resting behaviour (CT = 52.92 ± 1.02 s, CM = 51.62 ± 0.92 s, NS), latency for the first escape attempt (CT = 36.69 ± 2.81 s, CM = 36.69 ± 2.31 s, NS) and the frequency of resting behaviour (CT = 1.96 ± 0.14, CM = 1.95 ± 0.11, NS). Co-mingled piglets performed more escape attempts during the backtest than the control piglets (LS means CT = 1.05 ± 0.11, CM = 1.09 ± 0.08, $F_{1,56} = 4.94$, $P < 0.05$). Classification of piglets based on escape attempts as proposed by Hessing et al. (1994) did not differ between co-mingled and control litters both before co-mingling (NS) and after (NS).

During the isolation test, co-mingled and control piglets did not differ in the duration of active behaviour (CT = 563.40 ± 13.4 s, CM = 561.22 ± 8.08 s, NS), the frequency of active behaviour (CT = 2.26 ± 0.54, CM = 1.88 ± 0.15, NS) and the number of escape attempts performed (CT = 9.43 ± 1.62, CM = 12.52 ± 1.89, NS).

During the social challenge, co-mingled and control piglets differed in several behavioural responses. The results are summarized in Table 1.

4. Discussion

Co-mingling litters had little effect on piglets' weight gain, or suckling behaviour but resulted in greater ear injuries as previously reported (D'Eath, 2005). Ear injuries were greater 2 days after co-mingling (day 15), but these differences disappeared by day 18. Interestingly, this change was due to an increase in the proportion of control piglets with ear injuries.

We hypothesised that if co-mingling improved piglets' coping abilities before weaning then piglets' responses to behavioural tests designed to measure coping abilities would be indicative of such an affect. However, the results of the present study do not completely support our hypothesis. van Erp-van der Kooij et al. (2002) have suggested that coping can serve as both a trait variable or as a situation specific variable. Trait variables indicate that an individual's responses should be consistent over time and across situations. In this case, co-mingling should not have affected piglets' response to any of behavioural tests used to measure coping abilities. Situation specific variables indicate that the environment may play a role in determining and changing the coping style of an individual (van Erp-van der Kooij et al., 2002). Under these circumstances, co-mingling should have affected piglets' response to behavioural tests.

Our findings suggest that coping may act as both a trait variable and a situation specific variable. We found no treatment effects on piglets' response to the isolation test and most of the measure taken during the backtest. The most profound affect of co-mingling litters seems to be on piglets' response to the social challenge. Our results demonstrated that piglets that have been co-mingled were less aggressive and spent more time in proximity to one another during the social challenge than control piglets. Contrary to the findings reported by D'Eath (2005), we found that co-mingled piglets showed a longer latency to the first aggressive interaction. Our general finding that co-mingling has an effect on various aspects of piglet's social behaviour are in agreement with previous studies (Weary et al., 1999a; D'Eath, 2005; Parratt et al., 2006).

There are numerous reasons for the limited results in our experiment. First, the behavioural tests used may not have measured coping abilities affected by co-mingling. In this case, rearing environment alone cannot be thought to change the coping strategies used by pigs during the isolation and backtests. Second, the duration of co-mingling may not have been long enough to result in changes in coping abilities before weaning. The amount of time between co-mingling and weaning is very short under commercial US conditions. In systems, where weaning occurs later the effects of co-mingling on pre-weaning behaviour may be greater and easier to detect. Finally, co-mingling may not be sufficient to significantly affect piglets' response to the behavioural tests used in this experiment before weaning. Previous studies report that co-mingling results in an improvement in piglet's general abilities to cope with the stress of weaning (Weary et al., 1999a; Parratt et al., 2006). It is possible that a major stressor, such as weaning, is necessary in order for differences in coping abilities to be pronounced and detected broadly. Allowing piglets to co-mingle may have an exclusive affect on coping skills regarding social situations including two or more individuals, at least before weaning.

5. Conclusion

Our results suggest that co-mingling litters has an effect on the piglets' social skills, by primarily decreasing aggressive interactions during social challenges. Additional research is required to understand how co-mingling affects various aspects of piglets' coping abilities both before and after weaning.

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References

Benus, R.F., Bohus, B., Koolhaas, J.M., Oortmerssen, G.V.A., 1991. Heritable variation for aggression as reflection of individual coping strategies. Experientia 47, 1008–1019.

D'Eath, R.B., Burn, C.C., 2002. Individual differences in behaviour: a test of 'coping style' does not predict resident–intruder aggressiveness in pigs. Behaviour 139, 1175–1194.

D'Eath, R.B., 2005. Socialising piglets before weaning improves social hierarchy formation when pigs are mixed post-weaning. Appl. Anim. Behav. Sci. 93, 199–211.

Hessing, M.J.C., Hagelsø, A.M., van Beek, J.A.M., Wiepkema, P.R., Schouten, W.G.P., Krukow, R., 1993. Individual behavioural characteristics in pigs. Appl. Anim. Behav. Sci. 37, 285–295.

Hessing, M.J.C., Schouten, W.G.P., Wiepkema, P.R., Tielen, M.J.M., 1994. Implications of individual behavioural characteristics on performance in pigs. Livest. Prod. Sci. 40, 187–196.

Jensen, P., Forkman, B., Thodberg, K., Koster, E., 1995. Individual variation and consistency in piglet behaviour. Appl. Anim. Behav. Sci. 45, 43–52.

Koolhaas, J.M., Korte, S.M., De Boer, S.F., Van Der Vegt, B.J., Van Reenen, C.G., Hopster, H., De Jong, I.C., Ruis, M.A.W., Blokhuis, H.J., 1999. Coping styles in animals: current status in behavior and stress-physiology. Neurosci. Biobehav. Rev. 23, 925–935.

Parratt, C.A., Chapman, K.J., Turner, C., Jones, P.H., Mendl, M.T., Miller, B.G., 2006. The fighting behaviour of piglets mixed before and after weaning in the presence or absence of a sow. Appl. Anim. Behav. Sci.

Ruis, M.A.W., te Brake, J.H.A., Engel, B., Buist, W.G., Blokhuis, H.J., Koolhaas, J.M., 2001. Adaptation to social isolation: acute and long-term stress responses of growing gilts with different coping characteristics. Physiol. Behav. 73, 541–551.

van Erp-van der Kooij, E., Kuijpers, A.H., Schrama, J.W., van Eerdenburg, F.J.C.M., Schouten, W.G.P., Tielen, M.J.M., 2002. Can we predict behaviour in pigs? Searching for consistency in behaviour over time and across situations. Appl. Anim. Behav. Sci. 75, 293–305.

Weary, D.M., Pajor, E.A., Bonenfant, M., Ross, S.K., Fraser, D., Kramer, D.L., 1999a. Alternative housing for sows and litters2. Effects of a communal piglet area on pre- and post-weaning behaviour and performance. Appl. Anim. Behav. Sci. 65, 123–135.

Weary, D.M., Appleby, M.C., Fraser, D., 1999b. Responses of piglets to early separation from the sow. Appl. Anim. Behav. Sci. 63, 289–300.

Weary, D.M., Pajor, E.A., Bonenfant, M., Fraser, D., Kramer, D.L., 2002. Alternative housing for sows and litters. Part 4. Effects of sow-controlled housing combined with a communal piglet area on pre- and post-weaning behaviour and performance. Appl. Anim. Behav. Sci. 76, 279–290.